CHAPTER 6

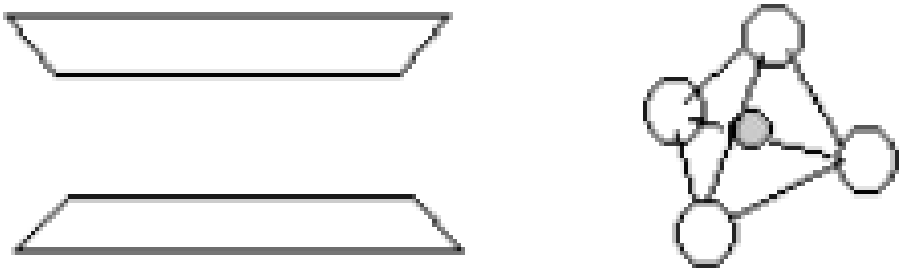
EXPANSIVE SOILS

Expansive soils are soils that expand when water is added, and shrink when they dry out. This continuous change in soil volume can cause buildings and infrastructure built on this soil to move unevenly and crack. Each year in the United States, expansive soils cause $2.3 billion in damages to houses, other buildings, roads, pipelines, and other structures. This is more than twice the damage from floods, hurricanes, tornadoes, and earthquakes combined (Kerrane). U.S. Housing and Urban Development (HUD) estimated $9 billion damages in 1981 resulting from expansive soils. It indicated that shrink-swell problems were the second most likely problem a homeowner would encounter, after insects. Expansive soils are a hazard recognized in the State Hazard Mitigation Plan (SHMP). The following hazard profile is based on information from the SHMP.

Expansive Soils Formation

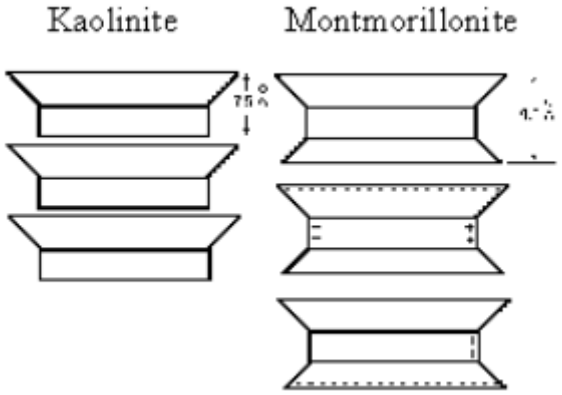
As igneous rock (primarily volcanic ash) breaks down through chemical weathering, it creates clay.

- Weathering breaks the parent rock apart and allows the atoms to recrystalize. These form Silicon Tetrahedron Sheets

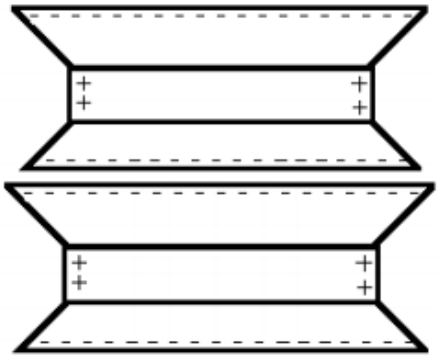


- and Aluminum Octahedral Sheets.

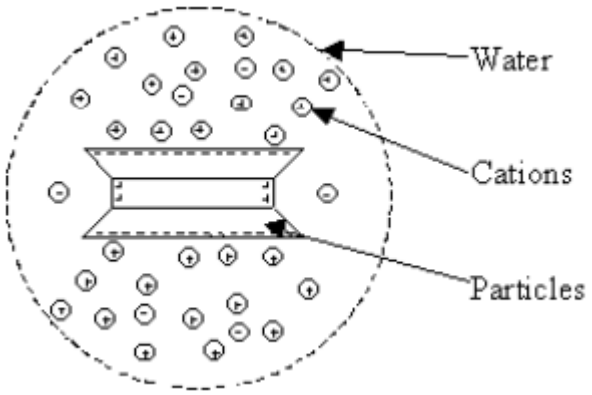
- Kalonites are formed in well drained soils, with an abundance of Oxygen, Silicon, and Aluminum. Since the constituents are "pure," these form very regular shapes which bind together in regular structures. These are held together in large stacks by strong Hydrogen Bonds.



- Montmorillonites are formed in poorly draining soils so that a wide variety of atomic species are available for recrystalization. When the aluminum octahedral are trying to form, sometimes "isomorphic substitution" occurs in which a magnesium atom substitutes for an aluminum atom. This creates irregular shapes and unbalanced charges with weak "van der Waals" forces between them.



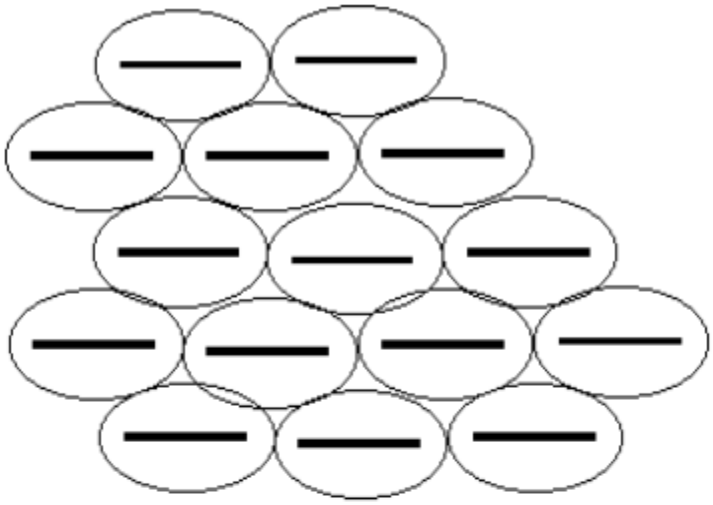
- To be electrically balanced, montmorillonites develop micelles with water and cations.



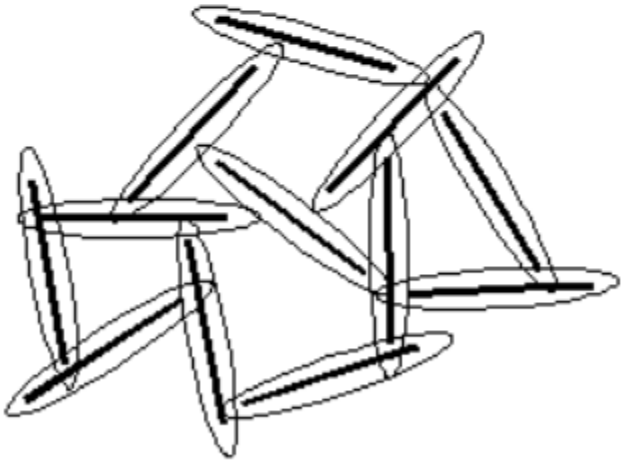
- Depending on the environment in which the clays form, they may be dispensed or

flocculated.

- This is the condition most “soils” (like the black soils) are in.



Dispersed Structure



Flocculated Structure

  - Over geologic time, these may be compressed and form clay to claystone to shale to schist.
  - Hence, the mineral has potential, the environment has the cause. (Edgar)

Some Wyoming clays have the potential to shrink and swell when they become wetted or dried. These clays are primarily montmorillonites. There is one type of montmorillonites, sodium montmorillonite (commonly known as bentonite), that is especially prone to shrinking and swelling. Another montmorillonite, calcium montmorillonite, also shows some shrink-swell capabilities. Areas where these clays are known to be present are shown in Figure 6.1. All of the areas shown on the map are geological formations that contain bentonite, except for the Casper

Mountain area in Natrona County where calcium montmorillonite is present. There are other areas in Wyoming with soils that have a shrink-swell component due to montmorillonites that are included in the soils. Those soils have not been completely mapped.

The hazard these expansive soils create can be significant although they have, for the most part, been recognized and mitigated in urbanized areas. Many of the expansive soils do not create large areas of destruction; however, they can disrupt supply lines (e.g. roads, power lines, railways, and bridges) and damage structures. Expansive soils do not change size quickly. Observing damage in real-time can sometimes be difficult. Although damage may not occur in a matter of minutes, it still has potential to severely damage structures and roads over time if not sufficiently mitigated.

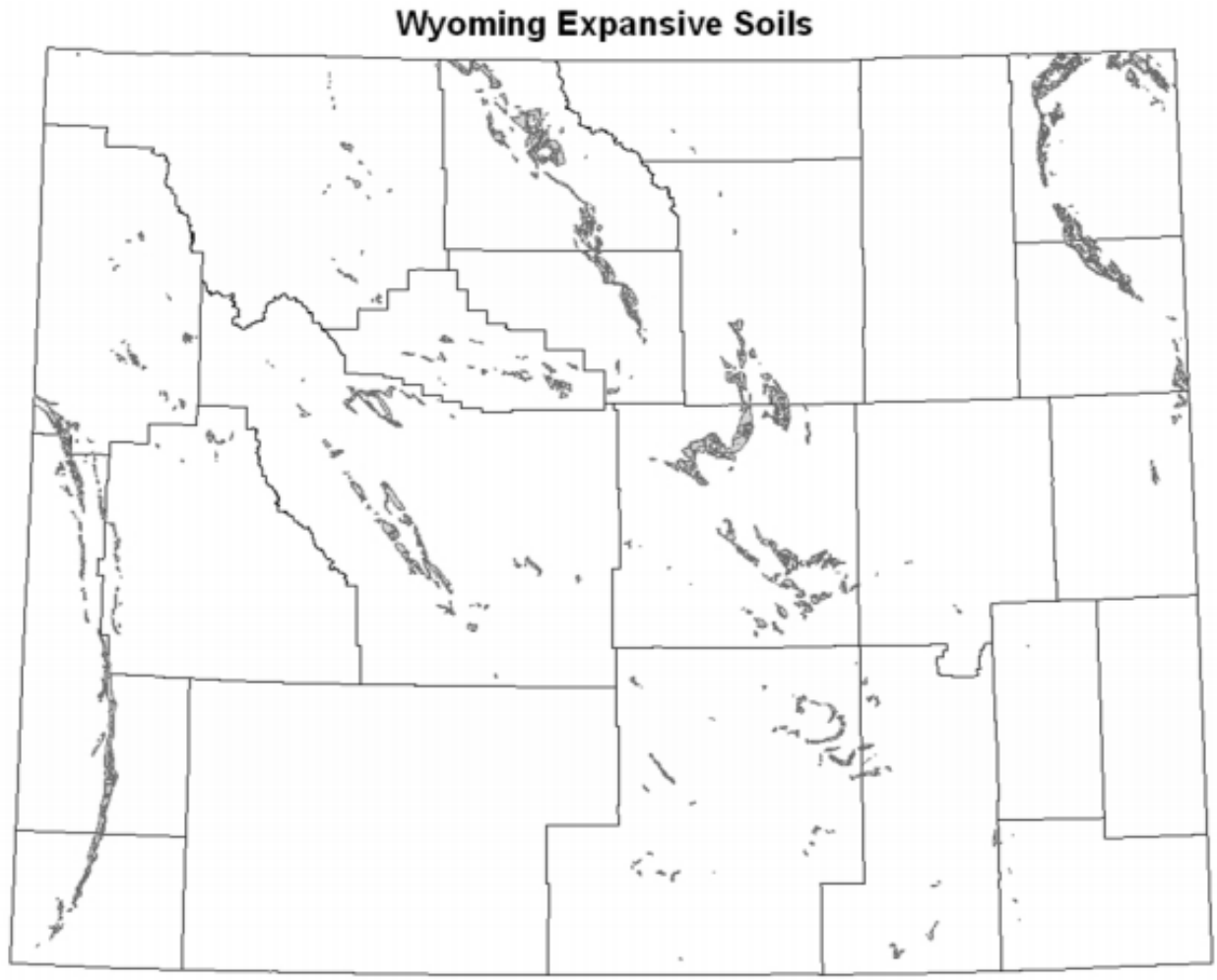
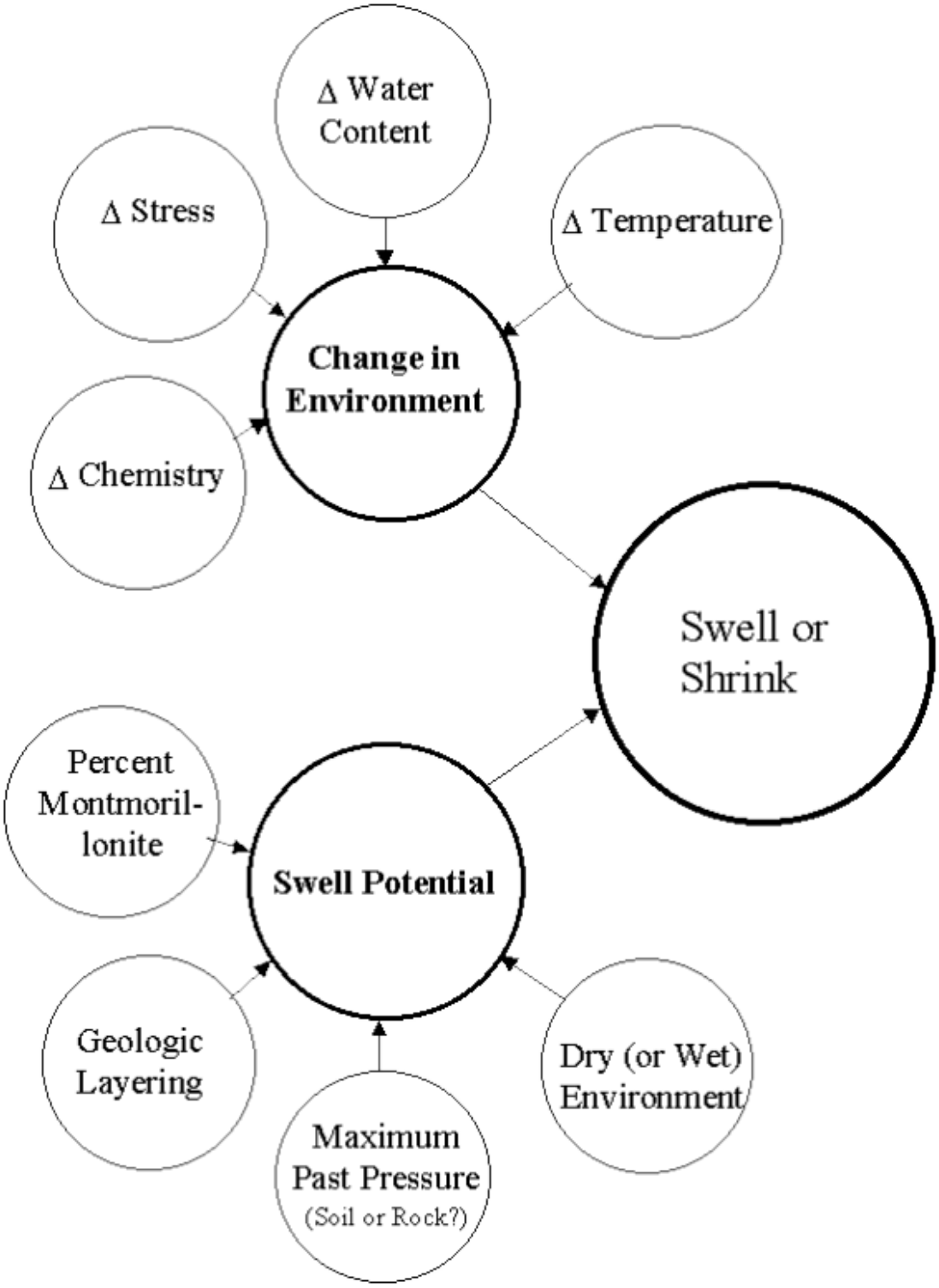


Figure 6.1 Possible Expansive Soils in Wyoming

Potential vs. Realized Swell

Many soils and rocks have the potential to swell. That is a function of its mineralogy. The actual swelling will be caused by a change in environment in which the material exists.



History

Very little work has been done to study the extent of expansive soils in Wyoming. Although there have been instances in the Casper area where foundations and other concrete work have been fractured and displaced, historical accounts of actual damaging events caused by expansive soils have been difficult to locate. Even less is known about expansive soil locations outside of the Casper area.

As seen in Figure 6.1, expansive soils are present along the flanks of the Black Hills, impacting Crook County. However, there are very few reports regarding expansive soils in this area.

Impacts

As previously mentioned, damage from known expansive soil areas has been very poorly documented. Collecting a dollar estimate of damage caused by expansive soils has proven difficult. It is estimated that there has been less than $5 million of actual expansive soil related damage in the Casper area and the rest of the state. The Crook County LEPC recognizes expansive soils as an issue in the County but could not recall any damages resulting from expansive soils.

Future Impacts

There are two measurements used for calculating future impacts, historic dollar damages, and building exposure values. There are not enough current data to accurately estimate historic damages, but an exposure analysis was completed with GIS. For the 2008 update to the State Plan, the Wyoming State Geological Survey (WSGS) calculated the building exposure value for buildings that may occur within the areas of expansive soils. All expansive soils mapped have been digitized and the expansive soils layer was then digitally overlaid with census block building values. In the event of an expansive soil boundary dissecting a census block, the proportional value of the buildings in the census block was assigned to the expansive soil. In a case where a census block is within an expansive soil, the combined values of all the buildings in the census block were assigned. The values derived by county are shown in Figure 6.2. The rank of counties based upon expansive soil building exposure values is shown in Table 6.1.

It is extremely unlikely that damage would occur to all property exposed in the map and table, meaning that the exposure estimates should not be considered true damage loss estimates. It is far more likely that damage from expansive soils will be individual events, which will cause damage to a small number of buildings or road segments over time.

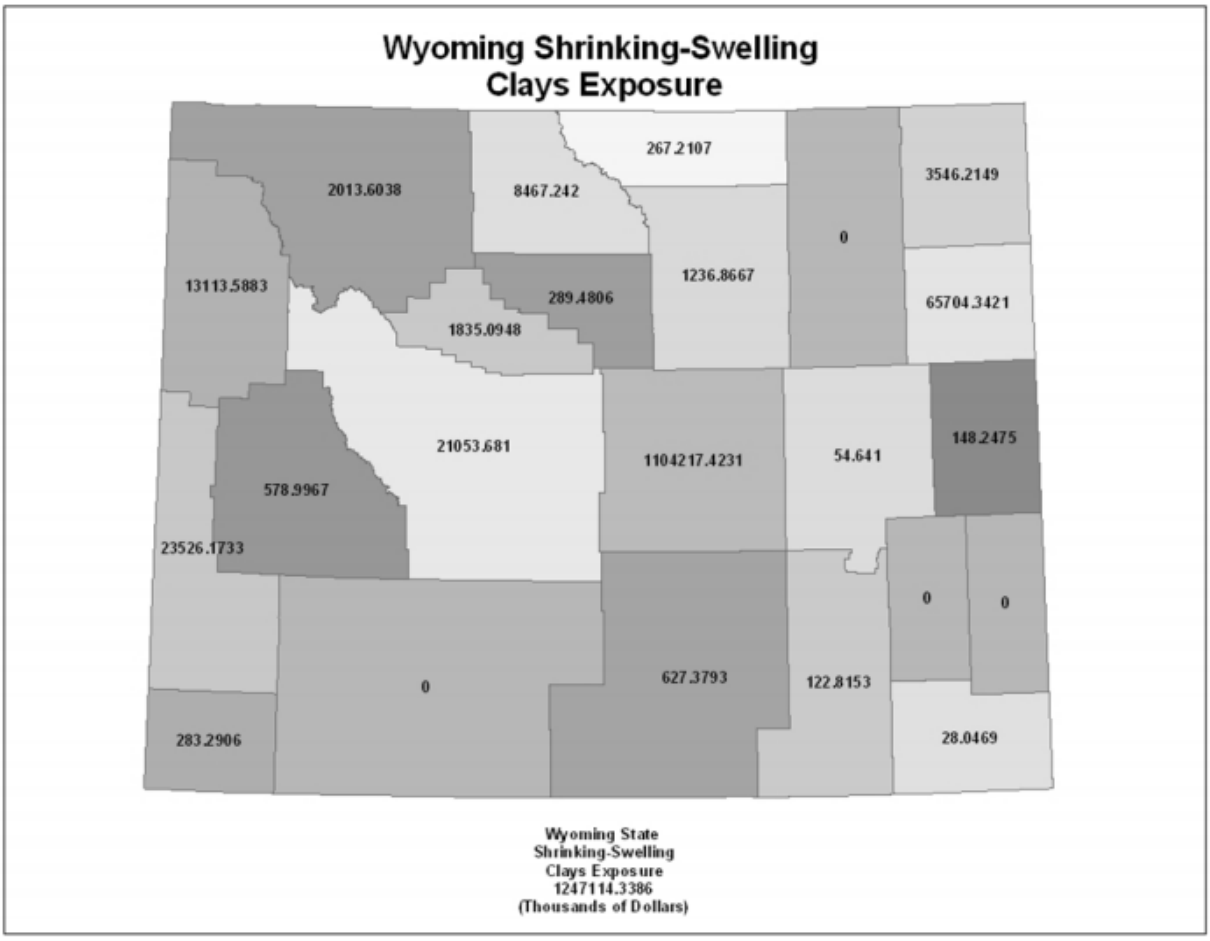


Figure 6.2 Building Exposure for Expansive Soils in Wyoming

Table 6.1 Building Exposure by County for Expansive Soils in Wyoming	
County	Exposure Value (USD)
Natrona	1,104,217,423
Weston	65,704,342
Lincoln	23,526,173
Fremont	21,053,681
Teton	13,113,588
Bighorn	8,467,242
Crook	3,546,215
Park	2,013,604
Hot Springs	1,835,095
Johnson	1,236,867
Carbon	627,379
Sublette	578,997
Washakie	289,481
Uinta	283,291

Table 6.1 Building Exposure by County for Expansive Soils in Wyoming	
County	Exposure Value (USD)
Sheridan	267,211
Niobrara	148,248
Albany	122,815
Converse	54,641
Laramie	28,047
Campbell	0
Goshen	0
Sweetwater	0
Platte	0
TOTAL	**1,247,114,339**

Given that the risk associated with expansive soils is most likely to be a small number of individual structures and short road segments over time, and that loss of life is not typically associated with expansive soils, it was determined not to further address population vulnerability as associated with the hazard of expansive soils in Crook County.

Despite the fact that expansive soils have not created significant damages in the past it is important for the County and its jurisdictions to be aware of the hazard as development occurs in the future. The potential for damage can be increased if construction occurs in areas of expansive soils without adequate mitigation efforts.

Summary

PROPERTY AFFECTED: Medium
POPULATION AFFECTED: Low
PROBABILITY: Low
JURISDICTION AFFECTED: County